

Technical Facilities at the CFN

Chuck Black

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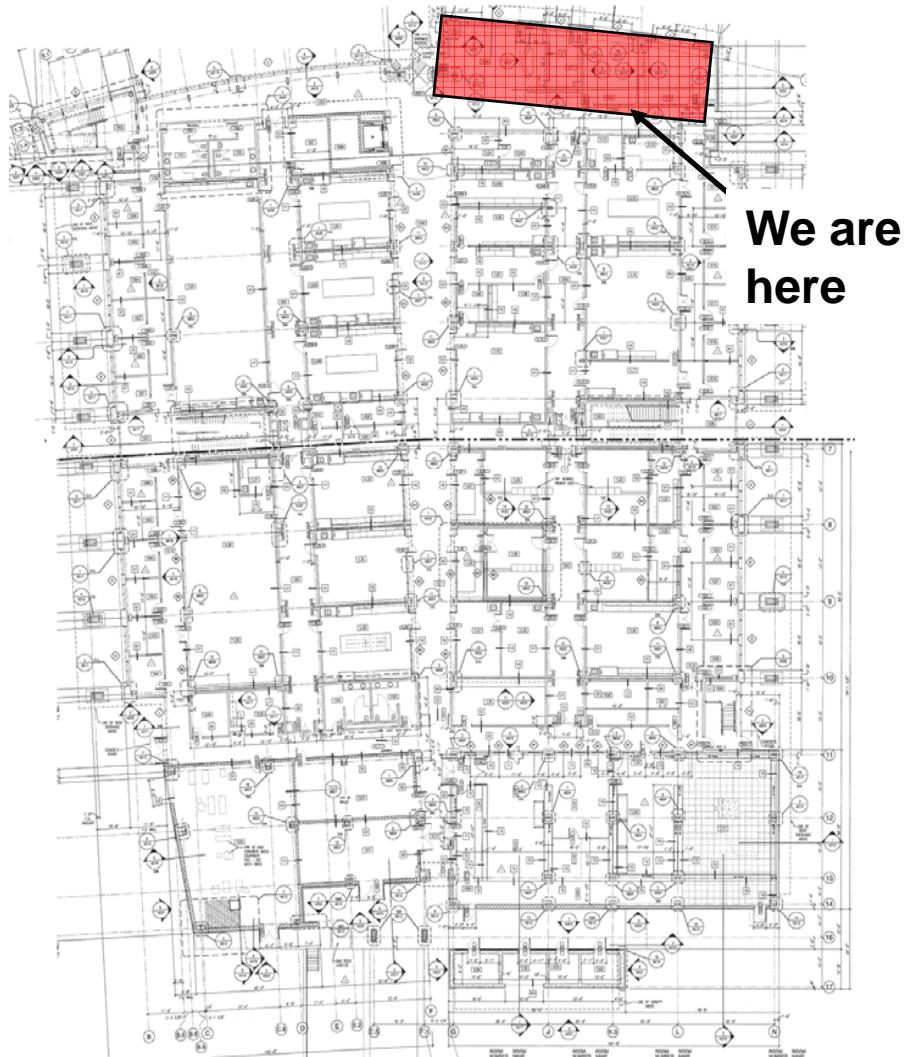
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Brookhaven National Laboratory



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The CFN Building

- 95,000 sq. ft.
- 25,000 sq. ft. of laboratory space
- 5,000 sq. ft. of cleanroom
- ~50 permanent staff (by ~2009)
- Office space for ~125 people



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CFN Facilities

Biology/Soft Matter

Materials/Thin Film Synthesis

Ultrafast Spectroscopy

Theory/Computation

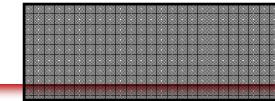
Surface Science

Electron Microscopy

Electrical Characterization

Nanofabrication

NSLS



Unique Instrumentation

- Improved spatial, energy, and time resolution
- Incorporate in-situ capabilities: property measurement in controlled environments

Hitachi HD2700C Scanning Transmission Electron Microscope

- 200kV cold field emission
- high-res electron energy loss spectrometer
- probe size 0.1nm, energy resolution 0.35eV

FEI Titan 80-300 Environmental TEM

- objective lens aberration correction
- custom-built environmental cell for observing chemical reactions
- spatial resolution : 0.1nm
- maximum pressure: 20mbar
- scanning, magnetic imaging, and chemical analysis capabilities



Hitachi HD2700C STEM



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Electron Microscopy

Yimei Zhu (zhu@bnl.gov)

High-quality general purpose tools

JEOL 2100F Analytical Transmission Electron Microscope

- 120-200kV scanning and field-emission TEM
- x-ray energy dispersive spectrometer for chemical analysis
- heating and cooling stages for in-situ experiments

JEOL 2100F TEM



Hitachi S-4800 Scanning Electron Microscope

- 0.1-30kV scanning electron microscope
- maximum sample diameter, 6"
- spatial resolution: 1nm (30kV), 2nm (1kV)

Hitachi S-4800 SEM



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Nanofabrication

Chuck Black (ctblack@bnl.gov)

5,000 sq. ft. of Class 1000 cleanroom

Molecular Imprints Imprio 55

- step/flash imprint tool
- ~20nm feature size demonstrated
- 5-40mm field size over 4" wafer
- sub-micron alignment accuracy

(at Alcatel-Lucent) JEOL JBX9300-FS

Electron-Beam Lithography Tool

- 100kV accelerating voltage
- sub-20nm minimum linewidth
- 1nm placement accuracy over 0.5mm field

Oxford PlasmaLab RIE

Trion Phantom III RIE

Trion Orion PeCVD

Kurt J. Lesker PVD75

- 3 source DC magnetron sputtering
- 4 source e-beam evaporation



CFN Nanofabrication Facility



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FEI Helios NanoLab

- Dual-beam focused ion beam system
- SEM imaging to 4M magnification
- EDX detector
- e-beam induced Pt deposition at ~10nm resolution
- Ga ion beam for ion milling/etching/ patterning at ~100nm resolution
- Pattern generator for ebeam/ion beam patterning of complex geometries
- Omniprobe manipulator for specimen handling



FEI Helios NanoLab



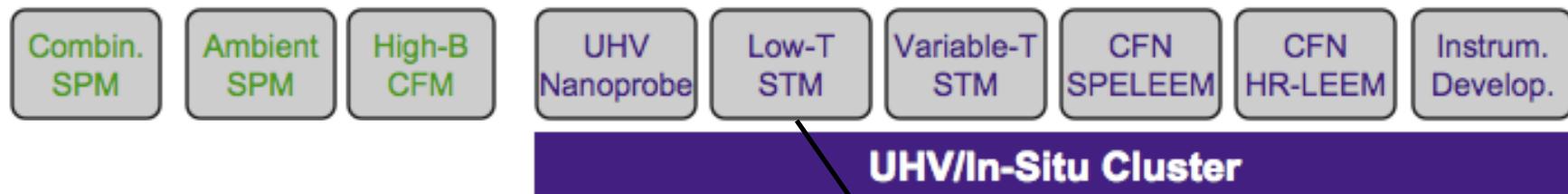
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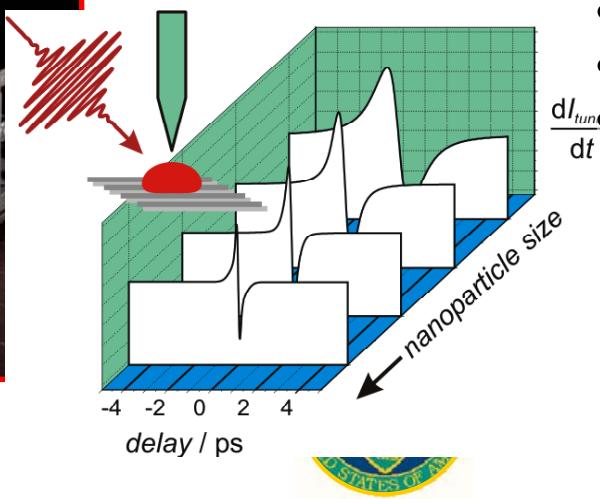
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Vision: “Microscopy beyond imaging”

- Broad suite of complementary instruments
- High-resolution mapping and probing of functional material properties
- Interrogate *individual* nanostructures



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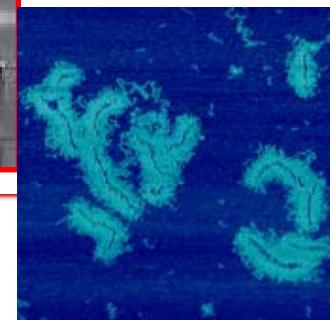
Vision: “Microscopy beyond imaging”

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Veeco Multimode V SPM

- Broad range of AFM imaging modes
- High-resolution STM & AFM
- Controlled ambient & fluids
- Temperature: -35 to 250°C



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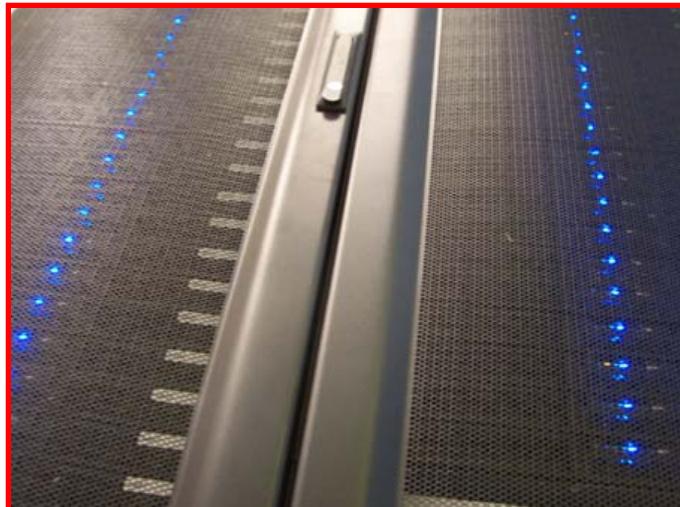
Theory and Computation

Mark Hybertsen (mhyberts@bnl.gov)

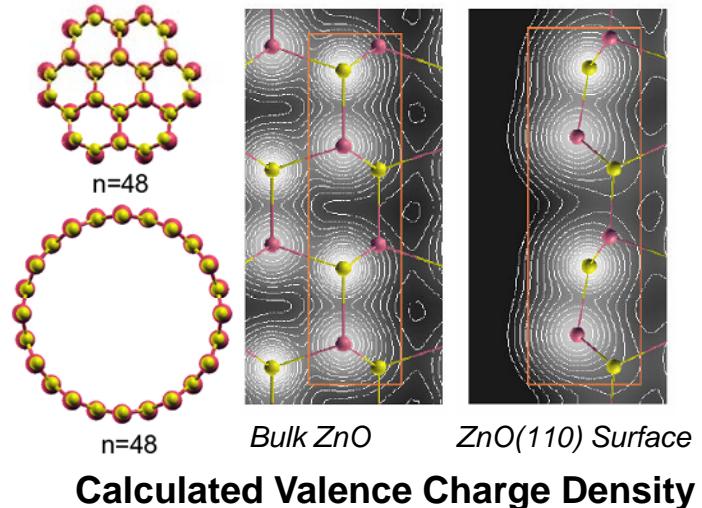
Support and collaboration for nanomaterials discovery

Provide scientific software for exploring fundamental properties of nanomaterials

- Quantum chemistry tools
- DFT packages for bonding & structure
- Tools for electronic excitations, optical properties



ZnO Nanostructures



Computational Facility:

- 50 node Linux Cluster
- 2.33 GHz dual/quad core Intel processors
- 400 processors, 3.7 teraflop/s peak
- 16 GByte / node, 24 TByte disk
- 20 Gb/sec Infiniband network



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Imaging

- Environmental Atomic Force Microscopy and force Spectroscopy
- Optical Fluorescent Microscopy, 3D and 2D (TIRF)
- Confocal Microscopy with multi-photon capabilities, spectral and time resolved imaging

Analytical

- UV-VIS-NIR spectroscopy
- Multi-wavelength ellipsometry
- FTIR
- Steady State and Life-Time Fluorometry
- X-ray reflectivity, X-ray diffraction
- Dynamic Light Scattering
- End-Station at NSLS

Single-Molecule Based Optical Methods

- Life-Time measurement
- Fluorescent Correlation Spectroscopy
- Fluorescence Imaging



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Ultrafast Spectroscopy

C. T. Black (ctblack@bnl.gov)

Spectroscopically probe dynamics of nanostructured systems on
~fs time scale

Amplified Ti:S laser system — 100 fs, ~3 mJ, 1 kHz

Optical Parametric Amplifier (OPA)

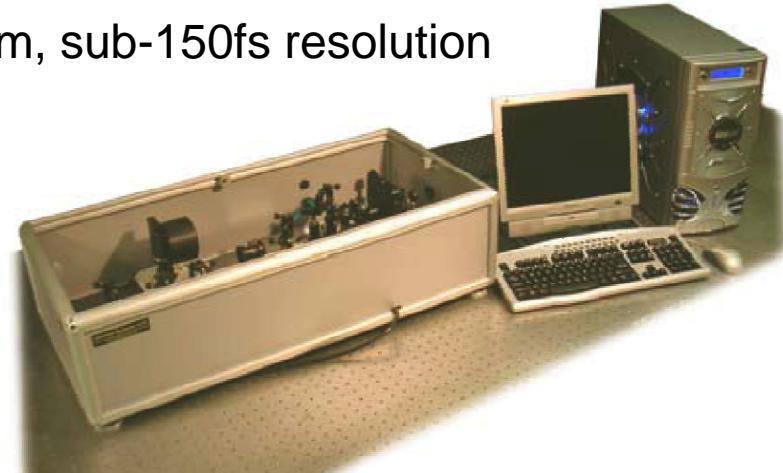
- 240–2600 nm wavelength range
- 25–30% signal + idler conversion efficiency

Femtosecond Spectrometer

- Transient absorption from 450-1600nm, sub-150fs resolution
- Transient emission

Key system features:

- Standard, robust technologies
- Nearly “turn-key”
- Broad wavelength tunability
- Peak power for nonlinear processes
- Medium repetition rate



Example instrument setup from: <http://www.ultrafastsystems.com>



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Contacts at the CFN

Biology/Soft Matter

- Dr. Oleg Gang (gang@bnl.gov)

Materials/Thin Film Synthesis

- Dr. Weiqiang Han (whan@bnl.gov)
- Dr. C. T. Black (ctblack@bnl.gov)

Ultrafast Spectroscopy

- Dr. Nick Camillone (nicholas@bnl.gov)
- Dr. Mircea Cotlet (cotlet@bnl.gov)

Theory/Computation

- Dr. Mark Hybertsen (mhyberts.bnl.gov)

Surface Science

- Dr. Peter Sutter (psutter@bnl.gov)

Electron Microscopy

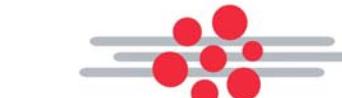
- Dr. Yimei Zhu (zhu@bnl.gov)

Electrical Characterization

- Dr. C. T. Black (ctblack@bnl.gov)

Nanofabrication

- Dr. John Warren (warren@bnl.gov)
- Dr. Aaron Stein (stein@bnl.gov)



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